PB90-166323

Proposed Best Demonstrated Available Technology (BDAT) Background Document for Chromium Wastes D007 and U032. Volume 21

(U.S.) Environmental Protection Agency, Washington, DC

Nov 89

U.S. Department of Commerce
National Technical Information Service
NTIS

50272-101

REPORT DOCUMENTATION PAGE	1. REPORT NO. EPA/530-SW-90-011U	2.	3. PB90-166323
4. Title and Subtitle PROPOSED BEST DEMONSTRATED AVAILABLE TECHNOLOGY (BDAT) BACKGROUND DOCUMENT FOR CHROMIUM WASTES D007 AND U032 (3RD 3RDS)			5. Report Date NOVEMBER 1989 6.
7. Author(s) CHATMON-McEADDY/OSW			8. Performing Organization Rept. No
9. Performing Organization Name and Address U.S. EPA Office of Solid Waste 401 M. Street SW Washington, DC 20460			10. Project/Task/Work Unit No. 11. Contract(C) or Grant(G) No. (C) (G)
12. Sponsoring Organization Name and Address			13. Type of Report & Period Covered BACKGROUND DOCU. - 11/89 14.

15. Supplementary Notes

16. Abstract (Limit: 200 words)

This background document provides the Agency's technical support and rationale for the development of proposed treatment standards for the constituents to be regulated for hte chromium-containing wastes. Sections 2 through 6 present waste-specific information fo rhte D007 wastes. Section 7 discusses associated chromium-containing U-code wastes and details the development of the proposed treatment standards for these wastes.

17. Document Analysis a. Descriptors

b. Identifiers/Open-Ended Terms

c. COSATI Field/Group

18. Availability Statement	19. Security Class (This Report)	21. No. of Pages
RELEASE UNLIMITED	UNCLASSIFIED	0
	20. Security Class (This Page) UNCLASSIFIED	22. Price 0

(See ANSI-Z39.18)

OPTIONAL FORM 272 (4-77)
(Formerly NTIS-35)

REPRODUCED BY
U.S. DEPARTMENT OF COMMERCE
NATIONAL TECHNICAL INFORMATION SERVICE
SPRINGFIELD, VA. 22161

EPA/530-SW-90-011C

PROPOSED
BEST DEMONSTRATED AVAILABLE TECHNOLOGY (BDAT)
BACKGROUND DOCUMENT FOR CHORMIUM WASTES D007 AND U032

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November 1989

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1. INTRODUCTION

Pursuant to section 3004(m) of the Resource Conservation and Recovery Act (RCRA), enacted as a part of the Hazardous and Solid Waste Amendments (HSWA) on November 8, 1984, the Environmental Protection Agency (EPA) is proposing treatment standards based on best demonstrated available technology (BDAT) for characteristic chromium-containing waste identified in 40 CFR 261.24 as D007 and for the commercial chemical product wastes identified in 40 CFR 261.33 as U032 - calcium chromate. Compliance with the final BDAT treatment standards is a prerequisite for the placement of these wastes in units designated as land disposal units according to 40 CFR Part 268. The effective date of final promulgated treatment standards for these wastes will be May 8, 1990.

This background document provides the Agency's technical support and rationale for the development of proposed treatment standards for the constituents to be regulated for the chromium-containing wastes. Sections 2 through 6 present waste-specific information for the D007 wastes. Section 2 describes the industries affected by regulation of these wastes, explains the processes generating these wastes, and presents available waste characterization data. Section 3 specifies the applicable and demonstrated treatment technologies for these wastes. Section 4 contains performance data for the demonstrated technologies, Section 5 contains analyses of these performance data to determine BDAT for each waste, and Section 6 contains the determination of the proposed BDAT treatment standards for the regulated constituents (chromium). Section 7 discusses associated chromium-containing U-code wastes (U032 - calcium chromate) and details the development of the proposed treatment standards for these wastes.

The BDAT program and promulgated methodology are more thoroughly described in two additional documents: Methodology for Developing BDAT Treatment Standards (USEPA 1989a) and Generic Quality Assurance Project

Plan for Land Disposal Restrictions Program ("BDAT") (USEPA 1988a). The petition process to be followed in requesting a variance from the BDAT treatment standards is discussed in the methodology document.

Standards are being proposed for the wastewater and nonwastewater forms of these wastes. For the purpose of determining the applicability of the proposed treatment standards, wastewaters are defined as wastes containing less than 1 percent (weight basis) total suspended solids* and less than 1 percent (weight basis) total organic carbon (TOC). Waste not meeting this definition must comply with the proposed treatment standards for nonwastewaters.

For nonwastewater forms of D007 and U032, stabilization** is determined to be BDAT based on performance data presented in Section 4. Likewise, for wastewater forms of D007 and U032, chemical chromium reduction followed by chemical precipitation and filtration is determined to be BDAT. The proposed treatment standard for nonwastewater and wastewater forms of D007 have been derived based on the performance of the BDAT technologies on "listed waste (K062)" that is expected to be similar to D007 and U032 wastes based on the concentrations of chromium and other BDAT list metals in the wastes. The proposed treatment

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* The term "total suspended solids" (TSS) clarifies EPA's previously used terminology of "total solids" and "filterable solids." Specifically, the quantity of total suspended solids is measured by Method 209c (Total Suspended Solids Dried at 103°C to 105°C) in Standard Methods for the Examination of Water and Wastewater, 15th Edition (APHA, AWWA, and WPCF 1985).

**As discussed in Section 3.1.1, EPA considers chemical precipitation with excess lime followed by filtration of the sludge to be essentially the same as stabilization when referring to treatment that results in nonwastewaters.

standards for chromium wastes are listed in Tables 1-1 and 1-2. Note that comments to the proposed rule indicate that the nonwastewater standard is not achievable. The Agency may promulgate a 5.2 mg/l treatment standard for chromium based on transfer of performance data for stabilization of F006 wastes.

Table 1-1 Proposed BDAT Treatment Standards for D007 Wastes

Constituent	Maximum for any single grab sample	
	Total composition	TCLP (mg/l)
Nonwastewaters		
Chromium (total)	Not applicable	0.094
Wastewaters		
Chromium (total)	0.32 mg/l	Not applicable

Table 1-2 Proposed BDAT Treatment Standards for U032 Wastes

Constituent	Maximum for any single grab sample	
	Total composition	TCLP (mg/l)
Nonwastewaters		
Chromium (total)	Not applicable	0.094
Wastewaters		
Chromium (total)	0.32 mg/l	Not applicable

2. INDUSTRIES AFFECTED AND WASTE CHARACTERIZATION

As defined in 40 CFR 261.24, D007 wastes are wastes that exhibit the characteristic of EP Toxicity for chromium. In other words, D007 wastes have a chromium concentration of greater than 5 mg/l, as measured by the EP Toxicity Leaching Procedure. Section 2.1 describes the industries affected by the land disposal restrictions for D007 wastes and describes the processes identified by EPA that may generate these wastes. Section 2.2 summarizes the available waste characterization data for these wastes. Section 2.3 uses the Agency's analysis of the sources of D007 wastes and waste composition in order to divide D007 wastes into waste treatability groups.

2.1 Industries Affected and Process Description

Chromium is used in industry as the metal and as various inorganic and organic chromium compounds. The major products containing chromium are chromium ore, alloys, chemicals, and the metal itself. The industries affected by the land disposal restrictions for D007 wastes are (1) the metallurgical industry, which produces chromium ferroalloys, metals, and other chromium containing materials; (2) the chemical industry which produces chromates, chromic acid, chromium pigments, and a wide range of chromium chemicals; and (3) the refractory industry, which produces chromite to make refractory bricks to line metallurgical furnaces. Processes in these industries that may generate chromium-containing wastes are discussed below.

2.1.1 Production of Chromium Chemicals and Pigments

A list of current manufacturers of the most common chromium compounds is provided in Table 2-1. All chromium metal and chromium compounds that are produced in the United States are derived from various grades of

Table 2-1 Current Manufacturers of Chromium Chemicals

Compound	Plant	Location
Chromic acid	American Chrome & Chemicals, Inc.	Corpus Christi, TX
	Occidental Petroleum Corporation; Occidental Chemical Corporation, Subsidiary	Castle Hayne, NC
	Allied Corporation	Baltimore, MD
Chromium oxide	Ferro Corporation, Color Division	Toccoa, GA
	National Industrial Chemical Co.	Chicago, IL
	Pfizer Inc.	Easton, PA
Chromium sulfate	Blue Grass Chemical Specialties	New Albany, NY
	Wayne Chemical Corporation	Milwaukee, WI
Potassium chromate/ dichromate	The Procter & Gamble Company J.T. Baker, Inc., subsidiary	Phillipsburg, NJ
	Allied Corporation	Baltimore, MD
Sodium chromate/ dichromate	American Chrome & Chemicals, Inc.	Corpus Christi, TX
	Occidental Petroleum Corporation; Occidental Chemical Corporation, subsidiary	Castle Hayne, NC
	Allied Corporation	Baltimore, MD
Calcium chromate	Barium & Chemicals, Inc.	Steubenville, OH
	National Industrial Chemical Co.	Chicago, IL

Reference: SRI 1989.

chromite ore. Chromite ores are generally classified according to the type of production process the chromite ore is eventually used in. Metallurgical chromite refers to the high chromium content chromite ore, chemical chromite to the high iron content chromite ore, and refractory chromite to high aluminum/low chromium content chromite ore.

Chromic acid (CrO_3) is produced by mixing sulfuric acid with sodium dichromate dihydrate in a heavy-walled steel or cast-iron reactor which is heated externally and stirred with an agitator. The resultant mixture of sodium chromate and sulfuric acid is heated to 197°C to melt the constituents, allowing the reaction to complete. These reactions proceed as follows:

$$Na_2SO_4 + Na_2Cr_2O_7 \cdot 2H_2O \rightarrow 2Na_2CrO_4 + H_2SO_4 + H_2O$$

$$Na_2CrO_4 + 2H_2SO_4 \rightarrow CrO_3 + H_2O + 2NaHSO_4$$

Upon cooling, the molten chromic acid separates from the sodium bisulfate byproduct. The molten chromic acid layer is tapped from the reactor and flaked on water-cooled rolls to produce the commercial product. Chromic acid is used extensively in metal finishing industry for the production of chemical conversion coatings and in decorative and hard chromium electroplating operations.

Chromium oxide (Cr_2O_3) is produced by reduction of an alkali dichromate in a self-sustaining dry reaction by a reducing agent such as sulfur, carbon, starch, wood flour, or ammonium chloride. The mixture of dichromate and an excess of reducing agent is ignited in a reverbatory furnace or small kiln transferred to leaching tanks (where reaction by-products are removed), filtered, washed, dried, and pulverized. The reduction reaction, using carbon as the reducing agent, is as follows:

$$Na_2Cr_2O_7 + 3C \rightarrow Cr_2O_3 + Na_2O + 3CO$$

Chromic oxide is used in the manufacture of chromium metal and aluminum-chromium master alloys and in pigments that are used where chemical and heat resistance are required.

Chromic sulfate ($Cr_2(SO_4)_3$) is manufactured by the sulfur dioxide reduction of sodium dichromate in an acid-resistant tank. The reaction is as follows:

$$Na_2Cr_2O_7 + 3\ SO_2 \rightarrow Cr_2(SO_4)_3 + Na_2O$$

After reduction is complete, steam is bubbled through the solution to decompose any impurities and remove excess sulfur dioxide. Chromic sulfate is used in leather tanning liquors and in textile mordants and dyes.

Potassium dichromate is made by reacting sodium dichromate with an equivalent amount of potassium chloride in a crystallization process. Potassium chromate is prepared by the reaction of potassium dichromate and potassium hydroxide. The reactions are as follows:

$$Na_2Cr_2O_7 + 2\ KCl \rightarrow K_2Cr_2O_7 + 2\ NaCl$$
$$K_2Cr_2O_7 + 2\ KOH \rightarrow 2\ K_2CrO_4 + H_2O$$

Potassium dichromate is used as an analytical standard for laboratory use and in tanning, dyeing, and pigment applications. Potassium chromate is used in metal finishing.

Sodium chromate is manufactured by roasting a mixture of ground chromium ore, soda ash, and lime in a rotary kiln. The reaction occuring in the kiln is as follows:

$$4\ FeO{\bullet}Cr_2O_3 + 8\ Na_2CO_3 + 8\ CaO + 7\ O_2 \rightarrow 8\ Na_2CrO_4 + 8\ CaCO_3 + 2\ Fe_2O_3$$

The kiln roast is discharged through a cooler and leached. The leached calcine residue is recycled to the raw materials mixing station. The crude chromate liquor is added to hydrolyzing tanks at a pH of 9 to precipitate alumina impurities. Removal of the precipitate by filtration will leave a refined sodium chromate liquor.

Sodium dichromate is produced by treatment of sodium chromate liquor with sulfuric acid. The reaction is as follows:

$$2Na_2CrO_4 + H_2SO_4 \rightarrow Na_2Cr_2O_7 + Na_2SO_4 + H_2O$$

The mixture is passed through an evaporator where sodium dichromate liquor is evaporated and a sodium sulfate byproduct is precipitated. The purified and concentrated dichromate liquor is crystallized, put through a crystal centrifuge, and dried as the final sodium dichromate product. Almost all chromium compounds are produced using either sodium chromate or sodium dichromate as the primary feedstock material.

Calcium chromate is manufactured by a proprietary process as a specialty chemical product. Calcium chromate is used as an oxidizing agent in the production of ferrochromium and in the production of pigments and metal finishing compounds.

2.1.2 Uses of Chromium and Chromium Chemicals

Table 2-2 lists the major uses of chromium and its compounds.

Chromium consumption can be atributed to three primary user groups or industries: metallurgical, chemical, and refractory. Uses of chromium in the metallurgical industry is for the production of stainless steels, full, low-alloy and electrical steels, carbon steels, and other metallurgical products that include cast irons and nonferrous alloys.

Table 2-2 U.S. Chromium Consumption, By Product (%)

Metallurgical	71.4
Wrought stainless and heat resisting steels	51.3
Tool steels	1.3
Wrought alloy steels	9.5
Cast alloy steels	3.1
Alloy cast irons	1.8
Nonferrous alloys	3.1
Other	1.3
Chemicals	15.1
Pigments	4.0
Metal finishing	3.3
Leather tanning	2.4
Drilling muds	0.7
Wood treatment	0.9
Water treatment	0.9
Chemical manufacture	1.1
Textiles	0.4
Catalyst	<0.3
Other	1.1
Refractories	13.5
Chrome and chrome-magnesite	2.2
Magnesite-chrome brick	3.1
Granular chrome-bearing	6.0
Granular chromite	2.2

Reference: Hartford 1978 and Westbrook 1978.

These chromium products are used primarily in the manufacture of transportation, electrical, and construction equipment, heavy machinery, and fabricated metal products. Chromium-containing listed wastes generated from the metallurgical industry include K061, K062, and F006. These wastes are discussed in the BDAT background documents for these waste codes (USEPA, 1988b,c,d).

Chromium is used in the chemical industry for manufacturing a wide variety of chromium chemicals, of which sodium chromate and sodium dichromate are the most commercially significant and produced in the largest volume. Other manufactured chromium compounds are manufactured using sodium chromate or dichromate as the primary feedstock material. The more important secondary chromium chemicals include chromic acid, potassium chromate and dichromate, basic chromic sulfate, and chromium pigments.

Chromic acid is used in chromium plating and for the production of chemical conversion coatings. In chromium plating, chromium is plated from solutions in which it is present as an anion onto various substrates such as steel, brass, aluminum, plastics, and zinc die castings. The deposition of chromium from chromic acid solutions provides the substrate with a decorative and corrosion resistant surface. In chemical conversion coating, chromate conversion coatings are produced on metals by chemical or electrochemical treatment with mixtures of hexavalent chromium and other compounds. These treatments convert the metal surface to a layer containing a complex mixture of chromium compounds that will prevent oxidation and provide corrosion protection. These operations consume large quantities of chromic acid, and generate waste electroplating and conversion coating solutions and sludges generated from wastewater treatment. Listed wastes associated with these operations are F006 and F019.

Potassium chromate and dichromate are used in metal finishing in tanning compounds, and as raw materials in the production of chromate color pigments and corrosion inhibiting pigments. Listed wastes associated with the production of chromium pigments are K002, K003, K004, K005, K006, K007, and K008.

Chromium sulfate ($Cr_2(SO_4)_3$) is used in leather tanning and textiles. In these applications, chromium is used for its ability to form stable complexes with proteins, cellulosic materials, dyestuffs, and various synthetic polymers.

Other uses of chromium compounds include the manufacture of metal corrosion inhibitors for circulating water systems and for wood preservation. The use of chromium compounds in wood preservation has been due largely to the excellent results achieved by chromated copper arsenate. The treated wood is free from bleeding, paintable, and of an attractive olive-green color.

Chromium is used in the refractory industry to produce chrome brick, chrome-magnesite brick, and other refractory materials to line furnaces, kilns, incinerators, and other high temperature industrial equipment. Other industrial sectors consuming chromium refractory include glass manufacturing, nonferrous metals production, primary minerals smelting, and ceramics production.

All of the above uses of chromium generate a variety of chromium-containing nonwastewaters and wastewaters. Treatment of the wastewaters usually generates chromium-bearing nonwastewater residues.

2.2 Waste Characterization

The Agency has data from EPA's 1986 National Survey of Hazardous Waste Generators on the approximate composition of the types of D007

wastes currently generated. The nonwastewater forms of D007 are shown to contain from 5.0 to 700,000 parts per million of chromium. Other BDAT list metals may also be present at percent level concentrations. Most nonwastewaters contain very low levels of organics.

The wastewater forms of D007 are shown to contain from 5.0 to 10,000 parts per million chromium. Frequently, other metals are also present. In a few cases, organics may be present at concentrations up to 1 percent.

Most of the facilities reporting generation of D007 wastes were plants producing industrial inorganic chromium chemicals and pigments, chromium plating and polishing operations, aluminum conversion coating operations, wood preserving facilities, and petroleum refineries. The wastes generated included plating solutions, stainless steel acid bath and rinses, chromium conversion coating process rinses, and wastewater treatment sludges from treatment of chromium-containing wastewaters.

2.3 Determination of Waste Treatability Groups

Characteristic wastes with the same waste code may be produced in different processes in one industry or in different industries, and thus may have different waste characteristics and may not be treatable to similar concentrations using the same technology. In these instances, the Agency may subdivide waste codes into several treatability groups. This is done when the chemical forms of the wastes are very different and clearly require different treatments or combinations of treatments. For example, inorganic and organometallic compounds containing the same metals frequently require different types of treatment. Based on a careful review of the generation of D007 wastes and available waste characterization data from a variety of chromium-containing wastes, the Agency has determined that all D007 nonwastewaters form a single treatability group. The Agency has also determined the same to be true for D007 wastewaters.

The concentration of chromium in D007 wastes is dependent on the waste type and the particular production process from which the waste is generated. However, all of the D007 wastes identified by the Agency in Section 2.2 are expected to be treatable to similar levels by use of the same technologies. All nonwastewater forms of D007 wastes for which EPA has characterization data have similar compositions in terms of waste characteristics that affect treatment performance for BDAT list metals. Specifically, D007 nonwastewaters are not expected to have high concentrations of organic compounds, which would have the most important effect on BDAT list metals treatment technologies for nonwastewaters. All wastewater forms of chromium are also expected to be treated by chemical reduction and chemical precipitation to similar levels by the same technologies for the same reasons as discussed above for nonwastewaters.

3. APPLICABLE AND DEMONSTRATED TREATMENT TECHNOLOGIES

Section 2 established a single treatability group for nonwastewater forms of D007, and another treatability group for wastewater forms of D007 wastes. This section identifies the treatment technologies that are applicable to treatment of these wastes and determines which, if any, of the applicable technologies can be considered demonstrated for the purpose of establishing BDAT.

To be applicable, a technology must be theoretically usable to treat the waste in question or to treat a waste that is similar in terms of the parameters that affect treatment selection. For detailed descriptions of the technologies applicable for these wastes, or for wastes judged to be similar, see EPA's Treatment Technology Background Document (USEPA 1989b.) To be demonstrated, the technology must be employed in full-scale operation for the treatment of the waste in question or a similar waste. Technologies available only at pilot- and bench-scale operations are not considered in identifying demonstrated technologies.

3.1 Applicable Treatment Technologies

The technologies applicable for treatment of chromium-containing wastes are those that reduce the concentration of chromium in the treated residual and/or reduce the leachability of chromium in the treated residual.

3.1.1 Treatment Technologies for Nonwastewaters

Chromium-containing nonwastewaters are generated as inorganic solids and sludges typically from treatment of wastewaters, or as ash or slag from thermal processes, such as incineration or metallurgical processes. The two technologies that the Agency has identified as applicable for

treatment of chromium-containing nonwastewaters are high-temperature metals recovery and stabilization. These technologies are described below.

(1) High-temperature metals recovery. The basic principle of operation for this technology is that metals are separated from a waste as pure metals or metal oxides through high-temperature thermal reduction processes that typically use carbon, limestone, and silica (sand) as raw materials. The carbon acts as a reducing agent and reacts with metal compounds in the waste to generate carbon dioxide and free metal. The silica and limestone serve as fluxing agents. Some metals volatilize and are captured by air pollution control devices (APCDs). Others remain behind in the residual slag. This process separates some of the volatile metals, typically for reuse, and reduces the concentration of those volatile metals in the furnace residuals. Hence, the amount of waste that needs to be land disposed is reduced. Occasionally the furnace residuals, which are more concentrated in the less-volatile metals, can be reused. This is the case with chromium, which is not relatively volatile compared to many other metals. High-temperature metals recovery technologies are discussed in detail in the Treatment Technology Background Document (USEPA 1989b).

(2) Stabilization technologies. Stabilization treatment technologies are designed to reduce the leachability of metals in the treated waste compared to that in the untreated waste. These technologies involve mixing the waste with lime/fly ash mixtures, cement, concrete mixtures, or other formulations, both proprietary and nonproprietary. The binder/waste mixture normally sets into a solid mass which can be land disposed. Stabilization technologies are discussed in detail in the Treatment Technology Background Document (USEPA 1989b).

It should be noted that stabilization can be incorporated as part of the chemical precipitation process by the addition of lime in concentrations significantly greater than the stoichiometric amount

needed for precipitation. The only additional treatment step required for minimizing the leachability of metals in the precipitate/stablized solids is sludge filtration. EPA considers precipitation with excess lime followed by filtration of the sludge to be effectively the same as stabilization of the precipitated residuals and will refer to this process as stabilization in the context of treatment for nonwastewaters. Relative to wastewaters, this treatment is referred to as chemical precipitation and filtration, as discussed below.

3.1.2 Treatment Technologies for Wastewaters

Chromium-containing wastewaters are generated from chromium plating and polishing operations, chemical manufacture, leather tanning, water treatment, or other uses of soluble chromium compounds. These wastewaters are typically generated as aqueous, acidic, inorganic solutions that may contain high concentrations (up to 10,000 ppm) of hexavalent chromium and other dissolved metals. The Agency has identified two technology trains applicable to treatment of chromium-containing wastewaters. These technologies are chromium reduction followed by chemical precipitation and filtration, and ion exchange. These technologies are described below.

(1) Chromium reduction/chemical precipitation/filtration. The basic principle of chromium reduction is to reduce the valence of chromium in solution from the hexavalent state (in the form of chromate or dichromate ions) to the trivalent state. Common reducing agents utilized include sulfur dioxide (SO_2), sodium sulfite ($Na_2S_2O_3$), and sodium metabisulfite ($Na_2S_2O_5$). The reduction reaction is usually accomplished at a pH ranging from 2 to 3. The typical reduction process, using sodium metabisulfite, proceeds as follows:

$$Na_2S_2O_5 + H_2O \rightarrow 2NaHSO_3$$

$$6NaHSO_3 + 4H_2CrO_4 + 3H_2SO_4 \rightarrow 2Cr_2(SO_4)_3 + 3Na_2SO_4 + 10H_2O$$

Chromium reduction technologies are discussed in detail in the Treatment Technology Background Document (USEPA 1989b).

Chemical precipitation is used when dissolved metals are to be removed from solution. This technology can be applied to a wide range of wastewaters containing dissolved chromium and other metals. The underlying principle of chemical precipitation is that metals in wastewater are removed by the addition of a treatment chemical that converts the dissolved metal to a metal precipitate. The precipitate settles out (and/or is filtered out) of solution, leaving a lower concentration of the dissolved metal present in the solution. The principal chemicals used to convert soluble metal compounds to the less soluble forms include hydrated lime ($Ca(OH)_2$), caustic soda (NaOH), sodium sulfide (Na_2S), and, to a lesser extent, soda ash (Na_2CO_3), ferrous sulfide (FeS), and several other chemicals, depending on the metal(s) to be removed.

In the treatment of wastewaters containing chromium, at the completion of the chromium reduction step, the trivalent chromium compounds are precipitated from solution as chromium hydroxide at a pH above 8. The insoluble trivalent chromium (in the form of chromium hydroxide) is then allowed to settle (and/or is filtered) from solution. Chemical precipitation is discussed in detail in the Treatment Technology Background Document (USEPA 1989b).

(2) Ion exchange. This technology is applicable to treatment of wastewaters containing relatively low concentrations of dissolved chromium. The chromium must be in a soluble ionic form (Cr^{+3}, CrO_4^{-2}) in order to be removed by this technology. The waste is passed through a bed of ion exchange resin beads. The resin adsorbs the soluble ions, thus removing them from solution. Ion exchange produces both a wastewater residual (from regeneration of the ion exchange resin) and a nonwastewater residual (the spent ion exchange resin). The spent

regenerant solutions (usually acid solutions) are more concentrated than the original untreated waste (though much lower in volume), and must be treated for chromium removal by chemical precipitation followed by filtration if the regenerant solution is not recyclable. Ion exchange is discussed in detail in the Treatment Technology Background Document (USEPA 1989b).

3.2 Demonstrated Treatment Technologies

High-temperature metals recovery as applied to chromium is currently demonstrated at manufacturing facilities. Stabilization is demonstrated for many wastes containing chromium and other BDAT list metals, including F006 wastes generated from electroplating operations.

Chemical reduction and chemical precipitation are demonstrated technologies which have been in full scale use for many years in the chemical and metals industries. In fact, effluent guidelines limitations for several segments of the inorganic chemicals industry that generate chromium-containing wastewaters are based on the use of chemical reduction and precipitation technologies (USEPA 1982). Ion exchange is also demonstrated at many metal finishing facilities, to remove chromium from wastewater and in many cases to also recover the removed chromium for reuse in the metal finishing process.

4. PERFORMANCE DATA BASE

This section presents the data available to EPA on the performance of demonstrated technologies (as described in Section 3) in treating the D007 wastes or similar wastes. These data are used elsewhere in this document for determining which technologies represent BDAT (Section 5) and for developing treatment standards (Section 6). Eligible data, in addition to full-scale demonstration data, may include data developed at research facilities or obtained through other applications at less than full-scale operation, as long as the technology is demonstrated in full-scale operation for a similar waste or wastes, as defined in Section 3.

Performance data, to the extent that they are available to EPA, should include the untreated and treated waste concentrations for a given constituent, values of operating parameters that were measured at the time the waste was being treated, values of relevant design parameters for the treatment technology, and data on waste characteristics that affect the performance of the treatment technology.

Where data are not available on the treatment of the specific wastes of concern, the Agency may elect to transfer data on the treatment of a similar waste or wastes using a demonstrated technology. To transfer data from another waste category, EPA must find that the wastes for which treatment standards are being developed are no more difficult to treat (based on the waste characteristics that affect performance of the demonstrated treatment technology) than the treated wastes from which performance data are being transferred.

4.1 Performance Data for Nonwastewaters

Presented in this section are data collected by EPA and submitted to EPA on treatment of various F-code and K-code wastes containing chromium. These data include performance data for high-temperature

metals recovery of K061 wastes, stabilization of various F006 wastes, and stabilization of a K062 waste. The Agency believes that the tested K061 was similar in waste characteristics to many D007 wastes (such as off-specification chromium chemicals and incinerator ash residues containing chromium). The available data show that chromium was present at significant (i.e., treatable) concentrations in the K061 wastes, which were from the primary production of steel in electric furnaces. Additionally, EPA believes that the treated F006 and K062 wastes were similar to D007 wastewater treatment sludges in terms of waste characteristics and chromium concentrations. Note that these F006 and K062 wastes, like D007 wastes, were generated from treatment of chromium-containing wastewaters using chemical precipitation or similar technologies.

4.1.1 Performance Data for High-Temperature Metals Recovery

The Agency has 9 data sets for treatment of K061 waste by high-temperature metals recovery. Tables 4-1 and 4-2 at the end of this section summarize the treatment performance data collected for high-temperature metals recovery for each of the 9 data sets. Seven of the data sets represent data that the Agency collected on a rotary kiln unit (presented in Table 4-1); the other data were submitted by industry and include two data sets from plasma arc furnace treatment (see Table 4-2).

Table 4-1 presents total composition data for the untreated waste and total composition and TCLP leachate data for the treated nonwastewater residual, as well as design and operating data for each sample set. Table 4-2 presents total composition data for the untreated waste, treated nonwastewater, treated scrubber wastewater, and TCLP leachate data for the treated nonwastewater. For each of these two data sets, there are no TCLP leachate data prov_ded for the untreated waste that can be used to compare to that of the treated waste in order to determine the reduction of chromium leachability.

For high-temperature metals recovery, treatment performance is measured by the reduction in the concentration of metal constituents in treatment residuals, as compared to the untreated waste, and also by the reduction of the leachability of the metals in the residual as compared to that in the untreated wastes. However, the data available to EPA in Tables 4-1 and 4-2 are not sufficient to show applicability of high-temperature metals recovery to treat D007 nonwastewaters because it is not clear that total chromium concentration in the residual or in the TCLP leachate from the residual are lower than in the untreated waste. Consequently treatment standards cannot be developed from these data.

4.1.2 Performance Data for Stabilization

The Agency has performance data for treatment of chromium-containing wastes using stabilization, as shown in Tables 4-3 and 4-4. The data presented in Table 4-3 are performance data developed from stabilization of a variety of chromium-containing F006 wastes. These data sets present untreated waste total composition and TCLP data and treated waste TCLP data, and were used in developing F006 treatment standards. The treatment data indicate that F006 wastes with untreated TCLP leachate concentrations exceed 360 mg/l can be treated to below the chromium characteristic level by well-designed and well-operated stabilization processes. (All wastes were treated to less than 1.21 mg/l in the TCLP leachate.) Note also in Table 4-3 that there are significant quantities of organic constituents in the wastes, none of which seem to adversely affect the treatability of chromium.

The data presented in Table 4-4 are performance data from treatment of a K062 waste by a technology train consisting of chromium reduction, followed by precipitation and filtration. During the precipitation step, excess lime had been added, and therefore the treatment for nonwastewaters was essentially the same as stabilization (see the discussion in Section 3.1.1). These performance data represent 11 data

sets. Total chromium concentrations in the TCLP extracts of the nonwastewater residuals were all below the detection limit of 0.050 mg/l, with the exception of 0.068 mg/l in Sample Set #4.

4.2 Performance Data for Wastewaters

As discussed in Section 4.1.2, the Agency has 11 data sets for treatment of a K062 waste by chromium reduction followed by chemical precipitation and filtration. The wastewater residuals had total chromium concentrations ranging from 0.10 to 0.20 mg/l.

Additional wastewater treatment data, primarily from EPA's Office of Water, have been analyzed for the development of concentration-based treatment standards for D007 and other wastewaters. Further information on these data, including the sources of the data and the treatment technologies used, can be found in the preamble to the proposed rule and in the Best Demonstrated Available Technology (BDAT) Background Document for Wastewaters Containing BDAT List Constituents (USEPA 1989d).

Table 4-1 Treatment Performance Data for High-Temperature Metals Recovery of K061 Waste: Waelz Kiln

Sample set[a]	Chromium concentration		
	Untreated waste[b] (ppm)	Furnace residual (ppm)	Furnace residual TCLP (mg/l)
Sample Set #1	905	662	<0.080
Sample Set #2	959	741	0.103
Sample Set #3	1,190	748	<0.080
Sample Set #4	903	978	<0.080
Sample Set #5	803	205	<0.080
Sample Set #6	909	477	<0.080
Sample Set #7	1,080	476	<0.080

[a] Some of the design and operating data associated with these data have been claimed to be confidential. The remaining design and operating data associated with these data are shown at the end of this table.

[b] Analysis prior to addition of lime, coke, etc.

Source: USEPA 1987a.

Table 4-1 (continued)

Waste Characteristics Affecting Performance[a]

Boiling Point (in increasing order) -

Mercury	356°C
Cadmium	765°C
Zinc	909°C
Lead	1760°C
Chromium	2672°C

Boiling Point of Metal - No low boiling point metals are present in concentrations that could impact product (recovered metal) purity and use.

Thermal Conductivity[b] - The thermal conductivity of K061 waste has been estimated to be approximately 28 Btu/hr-ft°F.

Design and Operating Data for Rotary Kiln High-Temperature Metals Recovery

Parameter	Nominal value[c]	Operating value						
		6/2/87			6/3/87			
		SS #1	SS #2	SS #3	SS #4	SS #5	SS #6	SS #7
Kiln temperature (°C)	700-800	780-840[d]	730-820[d]	740-840[d]	720-840[e]	800-1065[e]	575-740[e]	575-740[e]
Feed rate (ton/hr)		-	-	-	-	-	-	-
Rate of rotation (min/rev)		1.5	1.5	1.3	1.5	1.1	1.1	1.1
Zinc content (%)		-	-	-	-	-	-	-
Moisture content (%)		13.3	10.8	11.2	14.7	11.4	14.4	9.2
Carbon content (%)		-	-	-	-	-	-	-
Calcium/silica ratio		3.48	3.33	9.84	5.6	5.89	8.54	8.8

[a]The waste characteristics affecting performance for high-temperature metals recovery are relative volatility and the heat transfer characteristics of the waste. As the best approximate measure of the parameters, EPA is using boiling point and thermal conductivity.

[b]Thermal conductivity was calculated based on major constituents present in the waste and their respective thermal conductivities. This calculation can be found in the Administrative Record for K061.

[c]This system was built in the 1920s and was not originally designed for treatment of K061 waste. Nominal values were developed by the plant in lieu of design values.

[d]Values reflect those for kiln #2.

[e]Values reflect those for kiln #3.

- = This information is considered Confidential Business Information.

Source: USEPA 1987a.

Table 4-2 Treatment Performance Data for High-Temperature Metals Recovery of K061 Waste: Plasma Arc Reactor

Sample set	Chromium concentration: Untreated waste[a] (ppm)	Treated slag (ppm)	Treated slag TCLP (mg/l)	Treated wastewater (mg/l)
Sample Set #1 (Stainless Steel)	60,000-100,000	40,000-170,000	-	0.05-0.10
Sample Set #2 (Carbon Steel)	400-5,000	2,000-12,000	0.013	0.03-0.08

- = No data.

[a] For the untreated waste, EPA has values for ranges only. Data were not available on the specific untreated values that corresponded to the treated values.

Comments:

1. Data were not provided showing the specific operating conditions at the time the wastes were treated.

2. No data were provided on treatment characteristics that affect performance.

Source: SKF Plasmadust 1987.

Table 4-3 Treatment Performance Data for Stabilization of F006 Waste

Constituent	Concentration					
	Untreated waste		Treated waste - TCLP (mg/l)			
	Total (mg/kg)	TCLP (mg/l)	Binder-to-waste ratio[a] 0.2	0.5	1.0	1.5
Sample Set #1 (Source-unknown)						
Chromium	1,270	0.34	0.51	NR	NR	NR
Oil and grease	1,520	-	-	-	-	-
TOC	14,600	-	-	-	-	-
Sample Set #2 (Source-auto parts manufacturing)						
Chromium	755	0.76	0.40	0.39	NR	NR
Oil and grease	60	-	-	-	-	-
TOC	1,500	-	-	-	-	-
Sample Set #3 (Source-aircraft over-hauling facility)						
Chromium	716	0.43	0.08	0.20	NR	NR
Oil and grease	37,000	-	-	-	-	-
TOC	137,000	-	-	-	-	-
Sample Set #4 (Source-aerospace manufacturing-mixture of F006 & F007)						
Chromium	12.9	7.58	NR	NR	0.40	0.34
Oil and grease	3,870	-	-	-	-	-
TOC	8,280	-	-	-	-	-
Sample Set #5 (Source-zinc plating)						
Chromium	110	0.18	0.23	0.30	NR	NR
Oil and grease	1,150	-	-	-	-	-
TOC	21,200	-	-	-	-	-
Sample Set #6 (Source-unknown)						
Chromium	12,200	25.3	0.25	0.38	NR	NR
Oil and grease	20,300	-	-	-	-	-
TOC	28,600	-	-	-	-	-

Table 4-3 (continued)

Constituent	Concentration: Untreated waste Total (mg/kg)	Concentration: Untreated waste TCLP (mg/l)	Treated waste - TCLP (mg/l) Binder-to-waste ratio[a] 0.2	0.5	1.0	1.5
Sample Set #7 (Source-small engine manufacturing)						
Chromium	3,100	38.7	0.21	0.76	NR	NR
Oil and grease	2,770	-	-	-	-	-
TOC	6,550	-	-	-	-	-
Sample Set #8 (Source-circuit board manufacturing[b])						
Chromium	42,900	360	3.0	1.21	NR	NR
Oil and grease	130	-	-	-	-	-
TOC	550	-	-	-	-	-
Sample Set #9 (Source-unknown)						
Chromium	47.9	0.04	0.10	0.20	NR	NR
Oil and grease	30	-	-	-	-	-
TOC	10,700	-	-	-	-	-
Sample Set #10 (Source-unknown)						
Chromium	644	0.01	0.03	0.21	NR	NR
Oil and grease	1,430	-	-	-	-	-
TOC	5,960	-	-	-	-	-

- = Not applicable.

NR = Results of tests at this binder-to-waste ratio were not reported.

[a]Binder-to-waste ratio = $\frac{\text{weight of binder material}}{\text{weight of waste}}$

[b]Oil and grease and total organic carbon (TOC) have been identified by EPA as waste characteristics that affect the performance of stabilization.
[c]Circuit board manufacturing waste is not in its entirety defined as F006; however, an integral part of the manufacturing operation is electroplating. Treatment residuals generated from treatment of these electroplating wastes are F006.

Source: CWM 1987.

Table 4-4 Treatment Performance Data for Treatment of a K062 Waste by Chromium Reduction Followed by Chemical Precipitation and Vacuum Filtration

Constituent	Concentration			
	Untreated waste (ppm)	Treated nonwastewater		Treated wastewater (ppm)
		Total (mg/kg)	TCLP (mg/l)	
Sample Set #1[a]				
Chromium (hexavalent)	893	1.43	--	0.011
Chromium (total)	2,581	7,300	<0.050	0.12
Sample Set #2[a]				
Chromium (hexavalent)	807	1.04	--	0.19
Chromium (total)	2,279	7,400	<0.050	0.12
Sample Set #3[a]				
Chromium (hexavalent)	775	b	--	b
Chromium (total)	1,990	4,000	<0.050	0.20
Sample Set #4[a]				
Chromium (hexavalent)	0.6	0.92	--	0.042
Chromium (total)	556	2,400	0.068	0.10
Sample Set #5[a]				
Chromium (hexavalent)	917	0.741	--	0.058
Chromium (total)	2,236	11,500	<0.050	0.11
Sample Set #6[a]				
Chromium (hexavalent)	734	1.78	--	b
Chromium (total)	2,548	10,000	<0.050	0.10
Sample Set #7[a]				
Chromium (hexavalent)	769	--	--	0.12
Chromium (total)	2,314	16,300	<0.050	0.12
Sample Set #8[a]				
Chromium (hexavalent)	0.13	0.116	--	<0.01
Chromium (total)	831	2,800	<0.050	0.15
Sample Set #9[a]				
Chromium (hexavalent)	0.07	b	--	0.041
Chromium (total)	939	3,400	<0.050	0.10

Table 4-4 (continued)

Constituent	Concentration: Untreated waste (ppm)	Concentration: Treated nonwastewater Total (mg/kg)	Concentration: Treated nonwastewater TCLP (mg/l)	Concentration: Treated wastewater (ppm)
Sample Set #10				
Chromium (hexavalent)	0.08	0.078	--	0.106
Chromium (total)	395	4,400	<0.050	0.12
Sample Set #11				
Chromium (hexavalent)	0.30	1.24	--	<0.01
Chromium (total)	617	2,100	<0.050	0.18

[a] Untreated waste composite of K062 along with other non-K062 waste streams.

[b] Color interference.

Design and Operating Data

Sample set no.	pH[a]	Operating value: Suspended solids (mg/l)	Operating value: Dissolved solids (mg/l)	Operating value: Oil and grease (mg/l)
1	9	<1-100	1,900-118,100	<0.2-6
2	9	<1-100	1,900-118,100	<0.2-6
3	10	<1-100	1,900-118,100	<0.2-6
4	9	<1-100	1,900-118,100	<0.2-6
5	8	<1-100	1,900-118,100	<0.2-6
6	8	<1-100	1,900-118,100	<0.2-6
7	9	<1-100	1,900-118,100	<0.2-6
8	9	<1-100	1,900-118,100	<0.2-6
9	10	<1-100	1,900-118,100	<0.2-6
10	9	<1-100	1,900-118,100	<0.2-6
11	9	<1-100	1,900-118,100	<0.2-6

[a] The pH design value is 8-10.

Source: USEPA 1986.

5. IDENTIFICATION OF BEST DEMONSTRATED AVAILABLE TECHNOLOGY (BDAT)

This section presents the Agency's rationale for determining best demonstrated available technology (BDAT) for nonwastewater and wastewater forms of D007.

To determine BDAT, the Agency examines all available performance data on technologies that are identified as demonstrated to determine (using statistical techniques if necessary) whether one or more of the technologies performs significantly better than the others. The technology that performs best on a particular waste or waste treatability group is then evaluated to determine whether it is "available." To be available, the technology must (1) be commercially available to any generator and (2) provide "substantial" treatment of the waste, as determined through evaluation of treatment performance data. In determining whether treatment is substantial, EPA may consider data on the performance of a waste similar to the waste in question, provided that the similar waste is at least as difficult to treat. If the best technology is found to be not available, then the next best technology is evaluated, and so on.

5.1 Nonwastewaters

For nonwastewater forms of D007, EPA has treatment data from a similar wastes (F006 and K062) containing chromium and a variety of other metals. The Agency believes that the nonwastewater residuals from treatment of D007 wastes are not likely to be more difficult to stabilize than the F006 or K062 wastes shown in Tables 4-3 and 4-4. The F006 wastes contained as much as 42,900 mg/kg of chromium and as much as 137,000 mg/kg of TOC, which are levels comparable to the highest concentrations of these constituents expected to be present in untreated D007 nonwastewaters. The F006 stabilization data show that the chromium

concentration is reduced from as much as 360 mg/l in the untreated waste TCLP extract to levels never exceeding 1.21 mg/l in the stabilized waste TCLP extract. Accuracy adjustment of these treatment data is shown in Table 5-1. The K062 data show chromium extract levels ranging from <0.050 to 0.068 mg/l. Accuracy-adjustment results in a range of <0.074 to 0.10 mg/l. (A correction factor of 1.47 is applied to these data, as shown in Table B-8 of USEPA 1988e.) The accuracy-adjusted data are presented in Table 5-2.

Further, the Agency has no data suggesting that other methods of chromium treatment in nonwastewaters can be universally applied successfully to all D007 wastes. The data on high temperature metal recovery show that chromium is concentrated in the nonwastewater residual (slag) from these processes, but in a form that is less leachable. However, EPA does not have data showing that all forms of D007 wastes would be amenable to treatment by this recovery technology. Wastewater treatment sludges, for example, are not likely to be amenable to high temperature recovery methods for chromium. The Agency has thus determined that stabilization represents the best treatment for D007 wastes in nonwastewaters.

Note that an analysis of variance test on the two sets of stabilization performance data would show that the treatment used on the K062 waste is best.

5.2 Wastewaters

For wastewater forms of D007 wastes, EPA has data on treatment of a similar waste (K062) containing chromium and a variety of other metals by chromium reduction followed by chemical precipitation and filtration. The Agency believes that D007 wastewaters are no harder to treat than the K062 wastewaters shown in Table 4-4 because of the high concentration of chromium and other metals in the K062 wastes. The data presented in

Table 4-4 show that the hexavalent chromium concentration was reduced from 893 mg/l in the untreated waste to 0.011 mg/l in the treated wastewater; the total chromium concentration was reduced from 2,581 mg/l in the untreated waste to 0.12 mg/l in the treated wastewater. Accuracy adjustment of these treatment data is detailed in Table 5-3.

The data base developed by EPA's Office of Water (see USEPA 1989d) also supplies data on the treatment of wastewaters containing chromium. The Agency has determined, however, that these data represent treatment of wastes less difficult to treat than some D007 wastewaters. EPA has therefore not considered these data in development of wastewater treatment standards for D007.

Ion exchange may reduce chromium concentrations to levels similar to or lower than those achieved by chemical precipitation. However, regeneration of ion exchange resin systems will generate a wastewater residual stream (see Section 3.1.2(3)) that, if not directly recyclable, will probably still require treatment by reduction, chemical precipitation and filtration. The Agency has determined that chromium reduction followed by chemical precipitation and settling and/or filtration is the best technology for treatment of D007 wastewaters. The Agency is requesting comments on the use of ion exchange or any other process for recovering or treating chromium in wastewaters.

EPA has determined that the best demonstrated technologies specified above for the D007 treatability groups (i.e., stabilization for nonwastewaters and chromium reduction followed by chemical precipitation and filtration for wastewaters) are commercially available and provide substantial treatment. Hence, these technologies represent BDAT for D007 nonwastewaters and wastewaters.

Table 5-1 Summary of Accuracy Adjustment of Treatment Data for Chromium in Treated Wastewater Treatment Sludges - Stabilization of F006 (Lime/Fly Ash)

	Untreated waste concentration		Measured treated waste concentration	Percent recovery for matrix spike test	Accuracy-correction factor	Accuracy-adjusted TCLP leachate concentration (mg/l)
	Total (mg/kg)	TCLP (mg/l)	TCLP (mg/l)			
Sample Set No. 2 (0.5[a])	755	0.76	0.39	85.8	1.165	0.45
Sample Set No. 3 (0.2[a])	716	0.43	0.08	85.8	1.165	0.09
Sample Set No. 6 (0.5[a])	12,200	25.3	0.38	85.8	1.165	0.44
Sample Set No. 7 (0.5[a])	3,100	38.7	0.76	85.8	1.165	0.89
Sample Set No. 8 (0.5[a])	42,900	360	1.21	85.8	1.165	1.41

[a]Binder-to-waste ratio used.

Source: USEPA 1988d.

Table 5-2 Summary of Accuracy Adjustment of Treatment Data for Chromium (Total) in Treated Nonwastewaters - Stabilization of K062

	Untreated waste concentration Total (mg/kg)	Measured treated waste concentration TCLP (mg/l)	Percent recovery for matrix spike test	Accuracy-correction factor	Accuracy-adjusted TCLP leachate concentration (mg/l)
Sample Set No. 1	2,581	<0.050	68	1.47	0.074
Sample Set No. 2	2,279	<0.050	68	1.47	0.074
Sample Set No. 3	1,990	<0.050	68	1.47	0.074
Sample Set No. 4	556	<0.050	68	1.47	0.10
Sample Set No. 5	2,236	<0.050	68	1.47	0.074
Sample Set No. 6	2,548	<0.050	68	1.47	0.074
Sample Set No. 7	2,314	<0.050	68	1.47	0.074
Sample Set No. 8	831	<0.050	68	1.47	0.074
Sample Set No. 9	939	<0.050	68	1.47	0.074
Sample Set No. 10	395	<0.050	68	1.47	0.074
Sample Set No. 11	617	<0.050	68	1.47	0.074

Source: USEPA 1988c.

Table 5-3 Summary of Accuracy Adjustment of Treatment Data for Chromium (Total) in Treated Wastewaters - Chromium Reduction/Chemical Precipitation of K062

	Untreated waste concentration Total (mg/kg)	Measured treated waste concentration TCLP (mg/l)	Percent recovery for matrix spike test	Accuracy-correction factor	Accuracy-adjusted TCLP leachate concentration (mg/l)
Sample Set No. 1	2,581	0.12	68	1.47	0.1764
Sample Set No. 2	2,279	0.12	68	1.47	0.1764
Sample Set No. 3	1,990	0.20	68	1.47	0.294
Sample Set No. 4	556	0.10	68	1.47	0.147
Sample Set No. 5	2,236	0.11	68	1.47	0.162
Sample Set No. 6	2,548	0.10	68	1.47	0.147
Sample Set No. 7	2,314	0.12	68	1.47	0.1764
Sample Set No. 8	831	0.15	68	1.47	0.2205
Sample Set No. 9	939	0.10	68	1.47	0.147
Sample Set No. 10	395	0.12	68	1.47	0.1764
Sample Set No. 11	617	0.18	68	1.47	0.2646

Source: USEPA 1988c.

6. DEVELOPMENT OF BDAT TREATMENT STANDARDS

In Section 5, the Agency chose the best demonstrated available technology (BDAT) for both nonwastewaters and wastewaters based on the treatment data available to the Agency. In this section, proposed BDAT treatment standards will be developed based on the performance of these technologies. Chromium is selected as the only regulated constituent because it is the only constituent for which this waste is listed. If D007 wastes are mixed with other listed or characteristic hazardous wastes and thus contained other constituents, other treatment standards would also apply.

The Agency bases treatment standards for regulated constituents on the performance of well-designed and well-operated BDAT treatment systems. These standards must account for analytical limitations in available performance data and must be adjusted for variabilities related to treatment, sampling, and analytical techniques and procedures.

BDAT standards are determined for each constituent by multiplying the arithmetic mean of accuracy-adjusted constituent concentrations detected in treated waste by a "variability factor" specific to each constituent for each treatment technology defined as BDAT. Accuracy adjustment of performance data has been discussed in Section 5 in relation to defining BDAT. Variability factors account for normal variations in the performance of a particular technology over time. They are designed to reflect the 99th percentile level of performance that the technology achieves in commercial operation. (For more information on the principles of calculating variability factors, see EPA's publication Methodology for Developing BDAT Treatment Standards (USEPA 1989a).) Details on the calculation of variability factors for chromium-containing nonwastewaters and wastewaters are presented in this section.

6.1 Nonwastewaters

For D007 nonwastewaters, EPA is proposing treatment standards based on data from stabilization* of a K062 waste. EPA has determined that these data represent the performance of a well-designed, well-operated treatment system. The calculation of these treatment standards is shown in Table 6-1.

As noted in the preamble to the proposed Third Third rule, the Agency may promulgate a chromium standard of 5.2 mg/l based on the performance of stabilization of F006 wastes. The calculation for this alternative standard is shown in Table 6-2.

6.2 Wastewaters

For D007 wastewaters, the Agency is proposing treatment standards based on the performance of chromium reduction followed by chemical precipitation and filtration for treatment of K062 wastewaters. EPA has determined that these data represent the performance of a well-designed, well-operated treatment system. Calculation of treatment standards for these data are presented in Table 6-3.

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* Note that these "stabilization" data are performance data from chromium reduction followed by chemical precipitation and filtration. As discussed in Section 3.2.1, this treatment is essentially equivalent to stabilization in the context of treatment for nonwastewaters.

Table 6-1 Calculation of Nonwastewater Treatment Standards Using K062 Data

Regulated constituent	Accuracy-adjusted treated waste concentration[a] (mg/l) (1)	Mean treated waste concentration (mg/l) (2)	Variability factor (VF)[b] (3)	Treatment standard (total composition) (mg/l) (4) = (2) (3)
Chromium (total)	0.074	0.076	1.24	0.094
	0.074			
	0.074			
	0.10			
	0.074			
	0.074			
	0.074			
	0.074			
	0.074			
	0.074			
	0.074			
	0.074			

[a] From Table 5-2.

[b] See Methodology Document (USEPA 1989a) for calculation of variability factor.

Table 6-2 Calculation of Alternative Nonwastewater Treatment Standards Using F006 Data

Regulated constituent	Accuracy-adjusted treated waste concentration[a] (mg/kg) (1)	Mean treated waste concentration (mg/kg) (2)	Variability factor (VF)[b] (3)	Treatment standard (total TCLP (mg/kg) (4) = (2) (3)
Chromium	0.45	0.66	7.94	5.2
	0.09			
	0.44			
	0.88			
	1.41			

[a] From Table 5-1.

[b] See Methodology Document (USEPA 1989a) for calculation of variability factor.

Table 6-3 Calculation of Wastewater Treatment Standards Using K062 Data

Regulated constituent	Accuracy-adjusted treated waste concentration[a] (mg/l) (1)	Mean treated waste concentration (mg/l) (2)	Variability factor (VF)[b] (3)	Treatment standard (total composition) (mg/l) (4) = (2) (3)
Chromium (total)	0.1765	0.1698	1.69	0.32
	0.1765			
	0.2941			
	0.1471			
	0.1471			
	0.1618			
	0.1471			
	0.1765			
	0.2206			
	0.1471			
	0.1765			
	0.2647			

[a] From Table 5-2.

[b] See Methodology Document (USEPA 1989a) for calculation of variability factor.

Table 6-4 Proposed BDAT Treatment Standards for D007 Wastes

Constituent	Wastewater	Nonwastewater	
	Total composition (mg/l)	Total composition (mg/l)	TCLP (mg/kg)
Chromium	0.32	NA	0.094

NA - Not applicable.

7. U WASTE CODES

This section addresses regulation of the only U waste that is listed for chromium. This waste, calcium chromate, U032, is identified in 40 CFR 261.33 as "discarded commercial/chemical products, off-specification species, container residues, and spill residues thereof."

7.1 Industries Affected

Industries that may generate chromium-containing U032 wastes are the metallurgical industry in the production of ferrochromium (chromium-iron) alloy; the chemical industry in the production of pigments, oxidizing agents, corrosion inhibitors, and metal finishing compounds; and the battery manufacturing industry in the production of high-temperature batteries.

7.2 Applicable and Demonstrated Best Treatment Technologies

Calcium chromate (U032) is slightly soluble in water and soluble in diluted acids. EPA believes that calcium chromate wastes are primarily generated by facilities involved in the manufacture of pigments and metal finishing operations because these facilities are the most likely users of calcium chromate. U032 wastewaters are expected to be similar in nature to K062 and other wastes generated from metal finishing operations in terms of the concentration of chromium in the untreated waste and other waste characteristics affecting treatment performance. Therefore, the Agency believes that chromium reduction followed by chemical precipitation, filtration of the precipitate, and stabilization of the nonwastewater residual solids is applicable and demonstrated to treat these wastes. EPA has no other data suggesting that other treatment technologies are applicable or demonstrated for U032 wastes.

7.3 Determination of Best Demonstrated Available Technology

Because chemical reduction followed by chemical precipitation and filtration is the only treatment train demonstrated for wastewaters similar to U032, it is also considered the "best" treatment (see Section 5). Likewise, as discussed in Section 5, stabilization as performed on the K062 waste is considered "best" for nonwastewater forms of U032.

Chromium reduction, chemical precipitation, and stabilization are shown to provide substantial treatment of chromium in wastewaters and nonwastewaters (see Section 5). These technologies are also all commercially available. Therefore, these technologies are determined to be BDAT for U032 wastes.

7.4 Selection of Regulated Constituents

EPA is proposing treatment standards for chromium in both wastewater and nonwastewater U032. Chromium is the only Appendix VIII constituent for which this waste is listed, and it is the only BDAT list constituent that the Agency expects to find in the waste on a regular basis (unless this waste is mixed with other listed hazardous wastes, in which case other treatment standards would also apply).

7.5 Development of Proposed Treatment Standards

Treatment standards for chromium in U032 wastes are based on chemical reduction and chemical precipitation followed by settling and/or filtration for wastewaters and on stabilization for nonwastewaters. Treatment standards for these wastes were transferred from the performance of the BDATs for K062 waste. The calculation of these treatment standards is identical to the calculation of standards for D007 wastes. The calculations are shown in Tables 6-1 and 6-3 for nonwastewaters and wastewaters, respectively.

The Agency believes that the transfer of the performance data is technically feasible because of the high concentration of chromium present in the K062 waste, and because calcium chromate should be no more difficult to treat than hexavalent chromium compounds contained in K062.

All wastewater and nonwastewater residuals from treatment of U032 waste must meet the treatment standards presented in Table 7-1.

Table 7-1 Proposed Treatment Standards for U-Code Chromium Wastes

Constituent	Wastewater	Nonwastewater	
	Total composition (mg/l)	Total composition (mg/l)	TCLP (mg/kg)
Chromium (U032)	0.32	NA	0.094

NA - Not applicable.

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